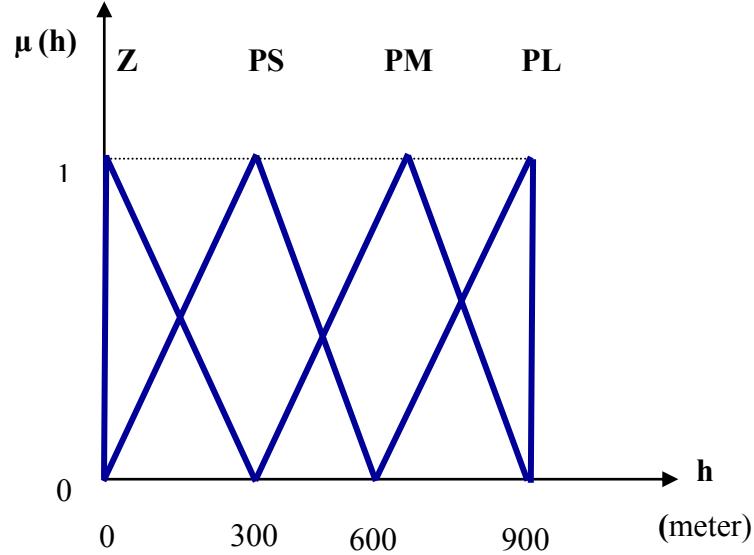


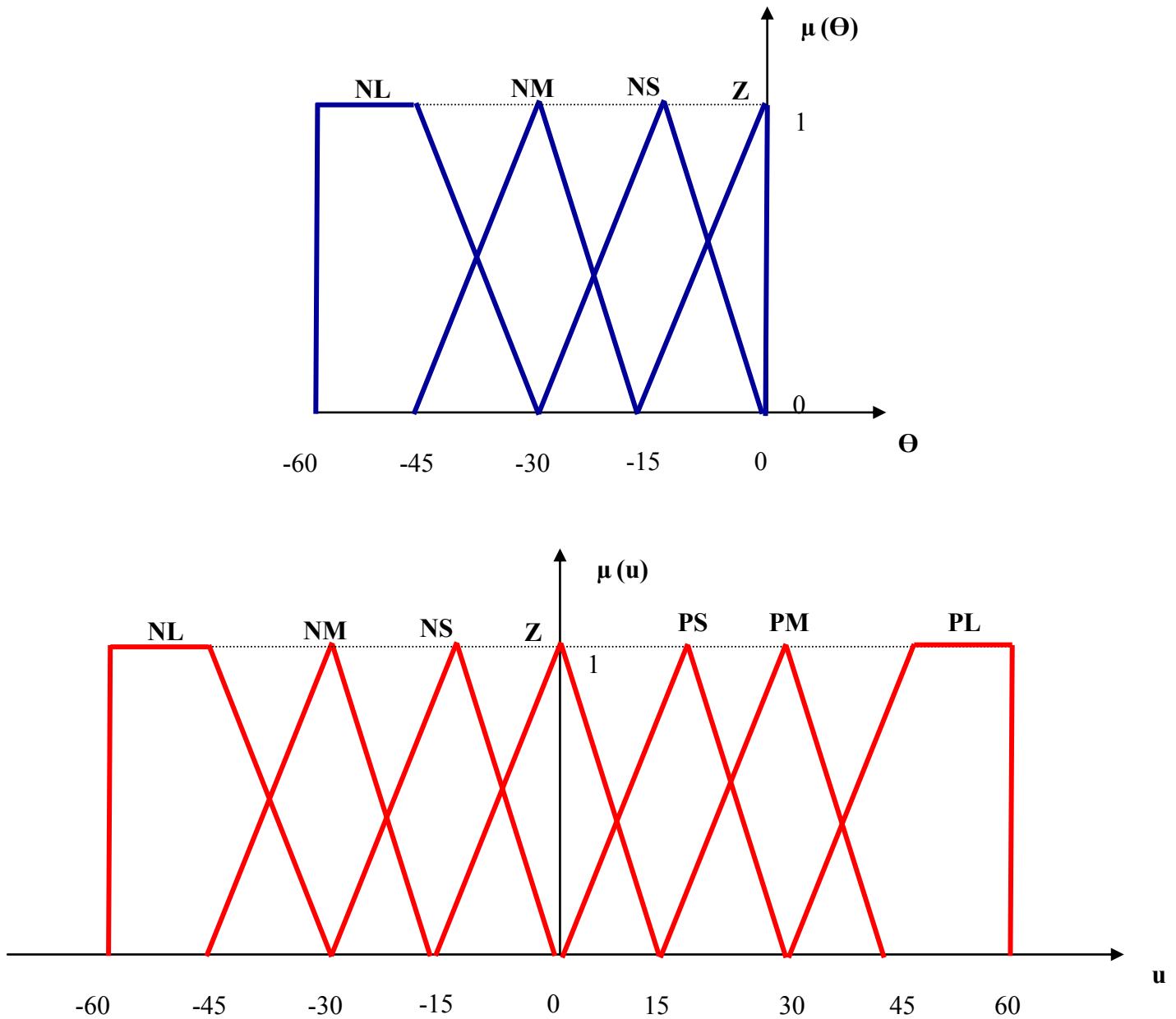
- 1- Using **MATLAB** program, open a new "fis" file and implement the following fuzzy controllers to land the plane safely with the following rules:

$\theta$ h	NL	NM	NS	Z
Z	PL	PM	PS	Z
PS	PM	PS	Z	NS
PM	PS	Z	NS	NM
PL	Z	NS	NM	NL



The fuzzy sets of inputs and output of the controller are shown in the following figures:





(a) Find the controller crisp output and fuzzy form output in the following cases:

- $\theta(t) = -27^\circ$  and  $h(t) = 100$  m.
- $\theta(t) = -43^\circ$  and  $h(t) = 255$  m.
- $\theta(t) = -10^\circ$  and  $h(t) = 450$  m.
- $\theta(t) = -35^\circ$  and  $h(t) = 200$  m.
- $\theta(t) = -20^\circ$  and  $h(t) = 4750$  m.

(b) View the surface of the fuzzy controller inputs and outputs.

2- Using the error signal ( $e$ ) and the change of error ( $\Delta e$ ), design a fuzzy-PD controller with the following specs:

- No. of fuzzy sets for the inputs (  $e$  and  $\Delta e$  ) is 5.
- No. of fuzzy sets for the output (  $u$  ) is 7.
- Use (NM , NS , Z , PS , PM) as the labels of the fuzzy sets inputs (  $e$  and  $\Delta e$  ).
- Use (NL , NM , NS , Z , PS , PM , PL) as the labels of the fuzzy sets output (  $u$  ).
- The universe of discourse :
  - $e \rightarrow$  from -4 to 4
  - $\Delta e \rightarrow$  from -1 to 1
  - $u \rightarrow$  from -9 to 9

(a) Draw the fuzzy sets for the inputs and output of the fuzzy controller.

(b) Write the suitable rules and use **MATLAB** program to implement the designed controller.

(c) Find the controller crisp output and fuzzy form output in the following cases:

- $e = 3$  and  $\Delta e = -0.5$
- $e = -2$  and  $\Delta e = -0.2$
- $e = 2.6$  and  $\Delta e = 0.35$

(d) View the surface of the fuzzy controller inputs and outputs.